

6. The gas treatment apparatus of claim 1 further comprising a reagent gas mixer [for] capable of mixing reagent gas with the effluent to further reduce the hazardous gas content of the effluent.

7. The gas treatment apparatus of claim 1 wherein the exhaust tube [is composed of] comprises monocrystalline sapphire[, and the gas energizer comprises a microwave generator for generating microwaves and a waveguide for coupling microwaves from the microwave generator to the exhaust tube to energize the effluent by microwaves].

8. The gas treatment apparatus of claim 1 [wherein the gas energizer comprises a plasma generator for coupling] further comprising an RF energy applicator to couple RF energy [into] to the effluent in the exhaust tube[to form a plasma from the effluent, the plasma generator comprising facing electrodes or an inductor coil].

9. The gas treatment apparatus of claim 1 wherein the exhaust tube comprises a distributor plate at an inlet of the exhaust tube, the distributor plate having holes [for directing] adapted to direct effluent preferentially along a flow surface of the exhaust tube.

10. The gas treatment apparatus of claim 1 further comprising:
(a) a gas analyzer for capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent; and
(b) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, [for] the computer controller system capable of monitoring the output signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following [steps]:

- (i) adjusting [the operating] a power applied to [level of] the gas energizer to reduce the hazardous gas content in the effluent,
- (ii) adjusting [the] process conditions in the process chamber to reduce the hazardous gas content in the effluent,
- (iii) activating an alarm or metering display,
- (iv) adding a reagent gas to the effluent [gas] before or after the effluent [gas] is energized, to reduce the hazardous gas content in the effluent, or
- (v) terminating the process being conducted in the process chamber.

11. A process chamber for processing a substrate and reducing emissions of hazardous gas to the environment, the process chamber comprising:

- (a) a support [for] capable of supporting the substrate in the process chamber;
- (b) a gas distributor [for] capable of introducing process gas into the process chamber;
- (c) a gas activator [for] capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas; and
- (d) [an exhaust system for exhausting and treating the effluent from the process chamber, the exhaust system comprising] an exhaust tube [for flowing] through which a continuous stream of the effluent may be flowed [therethrough and a gas energizer for energizing the effluent in the exhaust tube to reduce the hazardous gas content of the effluent]; and
- (e) a microwave energy applicator to couple microwaves to the effluent in the exhaust tube to energize the effluent.

20 12. The process chamber of claim 11 wherein the exhaust tube comprises at least one of the following characteristics:

A2 end (1) a length that is sufficiently long to reduce the hazardous gas content of the continuous stream of effluent flowing through the exhaust tube without [recirculation] recirculating the effluent in the exhaust tube;

(2) a length that is sufficiently long to provide a residence time of effluent in the exhaust tube that is at least about 0.01 seconds; or

(3) a flow surface that provides a laminar flow of effluent through the exhaust tube, the flow surface being parallel to the direction of the flow of the effluent through the exhaust tube and substantially absent projections or recesses that alter the effluent flow path.

Sub 13 14. The process chamber of claim 11 [wherein the gas energizer comprises a plasma generator for coupling] further comprising an RF energy applicator to couple RF energy [into] to the effluent in the exhaust tube [to form a plasma from the effluent, the plasma generator comprising facing electrodes or an inductor coil].

15. The process chamber of claim 11 wherein the exhaust tube [is composed of] comprises monocrystalline sapphire.

16. The process chamber of claim 11 further comprising:

(a) a gas analyzer [for] capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing an output signal in relation to the hazardous gas content of the effluent; and

(b) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, [for] the computer controller system capable of monitoring the output signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following [steps]:

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- (i) adjusting [the operating] a power applied to [level of] the gas energizer to reduce the hazardous gas content in the effluent,
 - (ii) adjusting [the] process conditions in the process chamber to reduce the hazardous gas content in the effluent,
 - (iii) activating an alarm or metering display,
 - (iv) adding a reagent gas to the effluent [gas] before or after the effluent [gas] is energized, to reduce the hazardous gas content in the effluent, or
 - (v) terminating the process being conducted in the process chamber.

24. A process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment, the process chamber comprising:

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- (a) a support [for] capable of supporting the substrate;
 - (b) a gas distributor [for] capable of introducing process gas into the process chamber;
 - (c) a gas activator [for] capable of activating the process gas to process the substrate thereby forming effluent containing hazardous gas; and
 - (d) [an exhaust system for exhausting and treating effluent from the process chamber, the exhaust system comprising] an exhaust tube [composed of] comprising monocrystalline sapphire through which effluent from the process chamber may be flowed, [a microwave source for generating microwaves, and a waveguide for coupling microwaves from the microwave source to the exhaust tube, whereby energizing the effluent in the exhaust tube by microwaves reduces the hazardous gas content of the effluent]; and
 - (e) a microwave energy applicator adapted to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent.

25. The process chamber of claim 24 wherein the exhaust tube comprises at least one of the following characteristics:

(1) a length that is sufficiently long to reduce the hazardous gas content of a continuous stream of the effluent flowing through the exhaust tube without [recirculation] recirculating the effluent in the exhaust tube;

(2) a length that is sufficiently long to provide an effluent residence time in the exhaust tube that is at least about 0.01 seconds; or

(3) a flow surface that provides a laminar flow of effluent through the exhaust tube, the flow surface being parallel to the direction of the flow of the effluent through the exhaust tube and substantially absent projections or recesses that alter the effluent flow path.

26. A process chamber for processing a [semiconductor] substrate in a process gas while reducing emissions of a hazardous gas to the environment, the process chamber comprising:

(a) a support [for] capable of supporting the substrate, a gas distributor [for] capable of introducing process gas into the process chamber, and a gas activator [for] capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas;

(b) [an exhaust system comprising] an exhaust tube [for] capable of exhausting the effluent from the process chamber and a gas energizer [for energizing] adapted to energize the [gas] effluent in the exhaust tube to reduce [the] a hazardous gas content of the effluent;

(c) a gas analyzer [for] adapted to monitor[ing] the hazardous gas content of the effluent in the exhaust tube and to provide [providing] an output signal in relation to the hazardous gas content of the effluent; and

(d) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, [for] the computer controller system capable of monitoring the output signal from the gas

analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one [of the steps] of:

- (i) adjusting [the operating] a power applied to [level of] the gas energizer to reduce the hazardous gas content in the effluent,
- (ii) adjusting [the] process conditions in the process chamber to reduce the hazardous gas content in the effluent,
- (iii) activating an alarm or metering display,
- (iv) adding a reagent gas to the effluent [gas] before or after the effluent [gas] is energized, to reduce the hazardous gas content in the effluent, or
- (v) terminating the process being conducted in the process chamber.

27. The process chamber of claim 26 wherein the computer readable program code on the computer readable medium comprises one or more of:

- (1) gas analyzer program code for receiving the output signals relating to the hazardous gas content of the effluent from the gas analyzer, and storing or passing the output signals to other program codes,
- (2) gas energizer program code for adjusting a power level of [a gas energizer] the microwave applicator in relation to the output signals,
- (3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the output signals, and
- (4) safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of [the steps of] (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows [in real time] the level of emissions of hazardous gas, or (4) shutting down the process chamber.

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28. A computer program product for operating a gas treatment apparatus and process chamber, to reduce the hazardous gas content of an effluent formed during processing of a [semiconductor] substrate in the process chamber, the gas treatment apparatus comprising an exhaust tube [for] capable of exhausting effluent from the process chamber, a gas energizer [for energizing] adapted to energize the effluent in the exhaust tube to reduce the hazardous gas content of the effluent, and a gas analyzer [for] adapted to monitor[ing] the hazardous gas content of the effluent in the exhaust tube and [providing] provide an output signal in relation to the hazardous gas content of the effluent,

the computer program product comprising a computer usable medium having computer readable program code embodied in the medium, the computer readable program code comprising:

- (a) gas analyzer program code for receiving the output signal relating to the hazardous gas content of the effluent from the gas analyzer, and storing or passing the output signal to other program codes; and
- (b) safety operational program code that upon receiving an output signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of [the steps of] (1) adjusting process conditions in the process chamber to reduce the hazardous gas emissions, (2) operating an alarm to indicate a dangerous level of toxic or hazardous gas in the effluent, (3) providing a metering display that shows [in real time] the level of emissions of hazardous gas, or (4) shutting down the process chamber.

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29. The computer program product of claim 28 wherein the computer readable program code comprises [gas energizer] program code for adjusting a power level of the [gas energizer] microwave energy applicator in relation to the output signal to reduce the hazardous gas emissions of the effluent.

Please add the following claims:

31. The gas treatment apparatus of claim 1 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

32. The gas treatment apparatus of claim 8 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

33. The process chamber of claim 11 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

34. The process chamber of claim 14 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

35. The process chamber of claim 24 wherein the microwave energy applicator comprises a waveguide for coupling microwaves to the effluent in the exhaust tube.

36. The process chamber of claim 28 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

REMARKS

I. STATUS OF CLAIMS

Claims 1-12, 14-16, 24-36 are pending in the application after claims 31-36 are added, and claims 13 and 17-23 are canceled. The claim amendments and